

Calorimeter Task Force

Interim Report



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- The Force
- Why to worry?
- A look at data and MC
- Status
- Interim recommendations
- Outlook



Calorimeter Task Force

Members:

Gregorio Bernardi, Volker Buescher, Christophe Clement, Silke Duensing, Anna Goussiou, Leslie Groer (co-chair), Marumi Kado, Nirmalya Parua, Serban Protopopescu, Dean Schamberger, Marek Zielinski (co-chair), Robert Zitoun

Charge:

The task force will determine the zero-suppression threshold for the calorimeter readout.

In order to fully understand the consequences of the zero-suppression threshold the Monte Carlo should be tuned to observed calorimeter energy and multiplicity distributions. Simulated data and collider data should be used to optimize the reconstruction and properties of physics objects as a function of threshold.

Selection of the threshold will also require an understanding of the L3 processing time and the data set size at L3 and off-line all as a function of threshold.

Specifically, the task force should:

1. Characterize the calorimeter performance on the cell level.
2. Characterize particle identification (such as energy response and resolution) as a function of threshold.
3. Tune the Monte-Carlo to the data at the cell and physics object levels.
4. Understand the consequences of the threshold level on L3 computing and data size and offline data size.
5. Recommend a zero-suppression threshold.

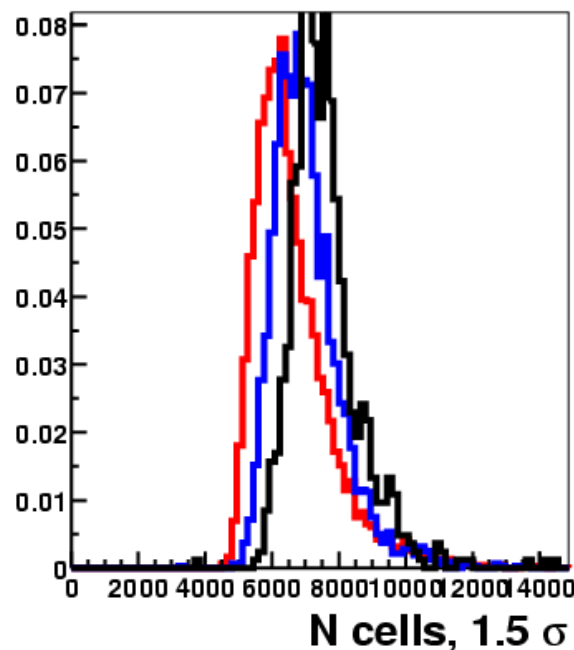
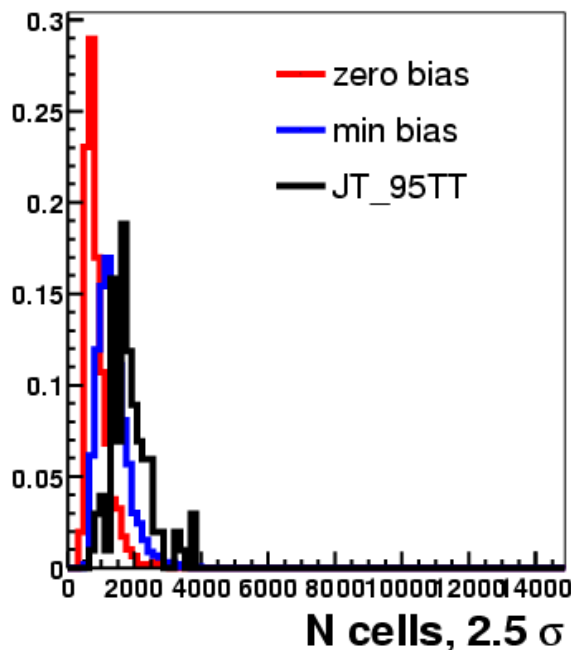
The task force will report to the spokespersons.

A preliminary recommendation should be available by October 15th
and a final report by January 15, 2003.

A story of zero-suppression

- Suppression threshold of 2.5σ for calorimeter cells was originally chosen based on Run I experience (σ being the RMS of online noise)
 - ➔ Run I noise was dominated by Uranium and not electronics – very different regime now
- Jet response, jet widths, taus too skinny etc. were interpreted that threshold was too high
 - ➔ High suppression removes noise, but also real shower energy
 - ➔ General consensus from the ID and physics groups that we need to go lower
- Changed threshold on June 26 from 2.5σ to 1.5σ
 - ➔ First run #158062
 - ➔ Occupancies gone from 3% to 15%
 - ➔ Processing time increased sharply
- In p11.11 (Aug 10) reintroduced a “ 2.5σ ” zesu offline
- But what happened in data?

Calorimeter occupancy



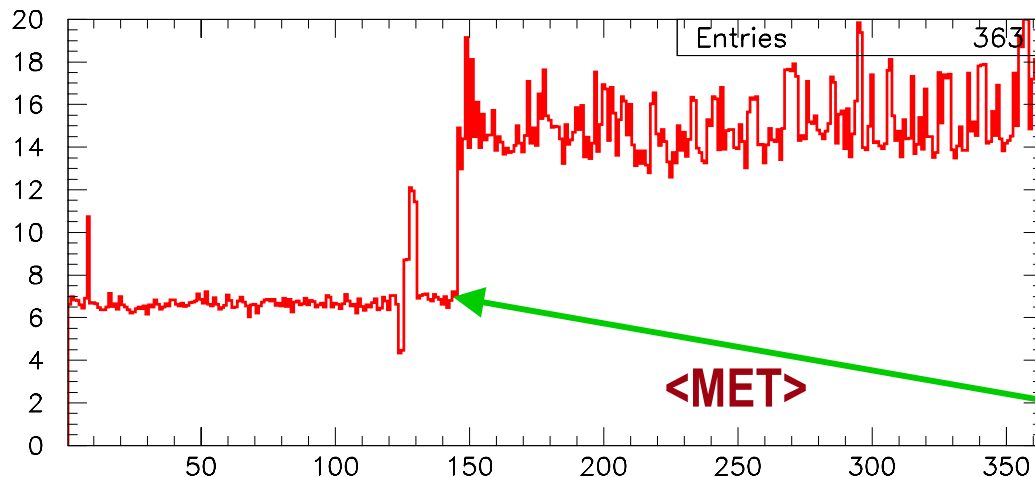
- Average occupancy up by factor 4-6

	<u>2.5σ</u>	<u>1.5σ</u>
Zero-bias	0.9k	6.5k
Min-bias	1.4k	7.0k
JT_95	1.9k	7.6k

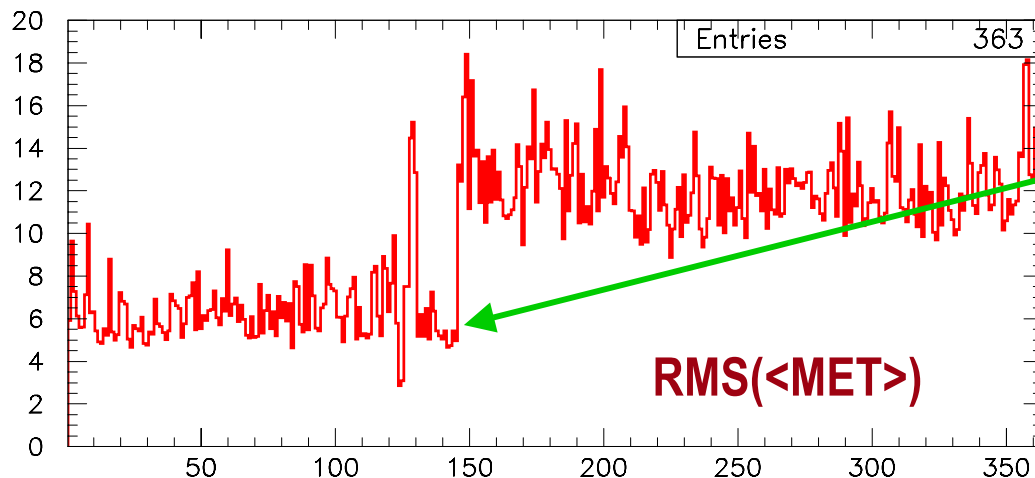
Silke Duensing

Missing E_T very sensitive

Gregorio Bernardi



Missing ET for selected root-tuple . June-July data p11.09



RMS-set-A (Missing ET) per root-tuple . June-July data METNE-p11.09

Major change of average missing E_T when going from 2.5 to 1.5 sigma zero-suppression cut:
From 6-7 GeV to 14-18 GeV, with a wider scattering from run to run.

Also true for RMS(MET)

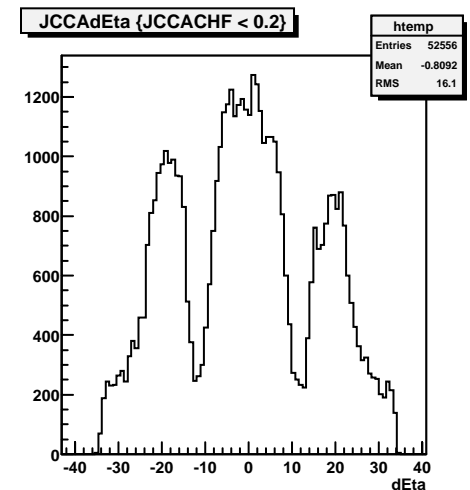
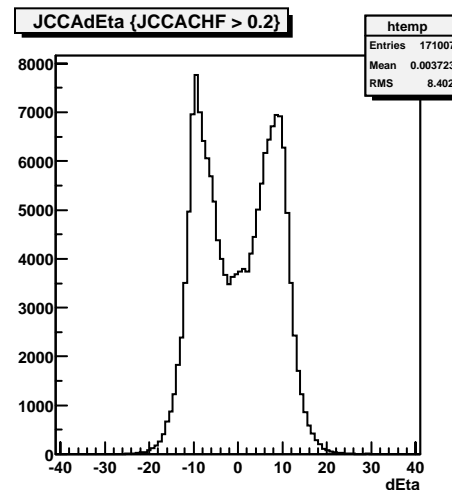
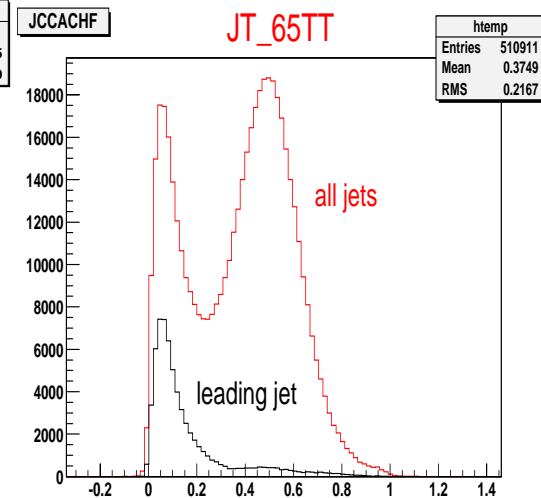
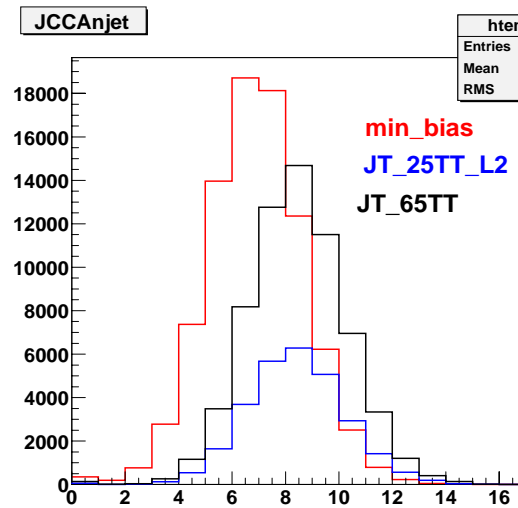
One entry per root-tuple, data from 19th June till 9th of July.

Not shown -- MET_x and MET_y are also skewed at low threshold

What's wrong with the jets?!

- July data, p11.09, 1.5σ zesu
 - ➔ Very high jet multiplicity
 - ❖ Could not even study dijet resolution!
 - ➔ Large CH fraction, persisting to high p_T
 - ➔ Enhancement of bad jets (and suppression of good jets) in ICR
 - ➔ High split-merge activity

Alexander Kupco
Vu Anh Tuan



Could it be zero-suppression?

- Comparisons for run 162594, processed twice:

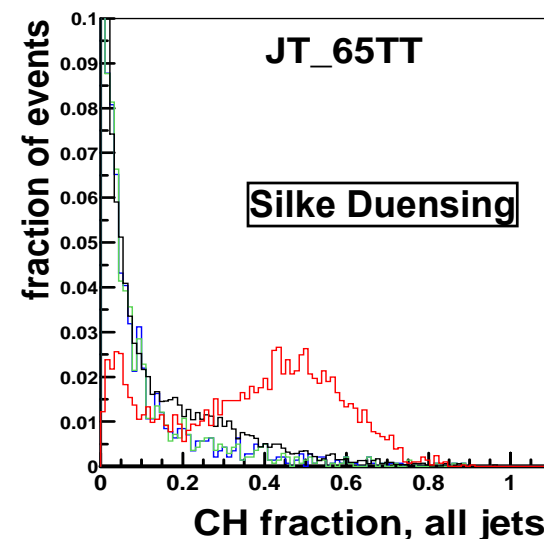
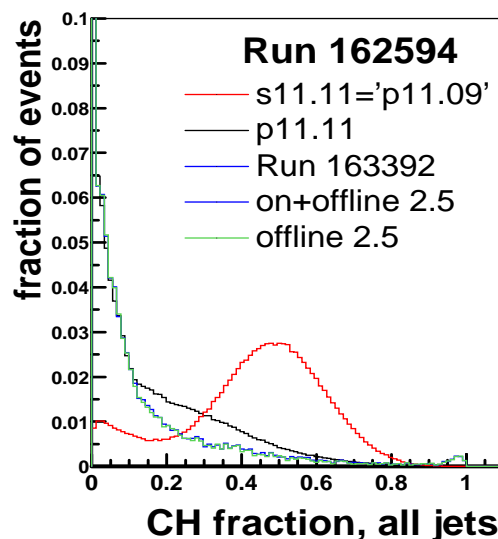
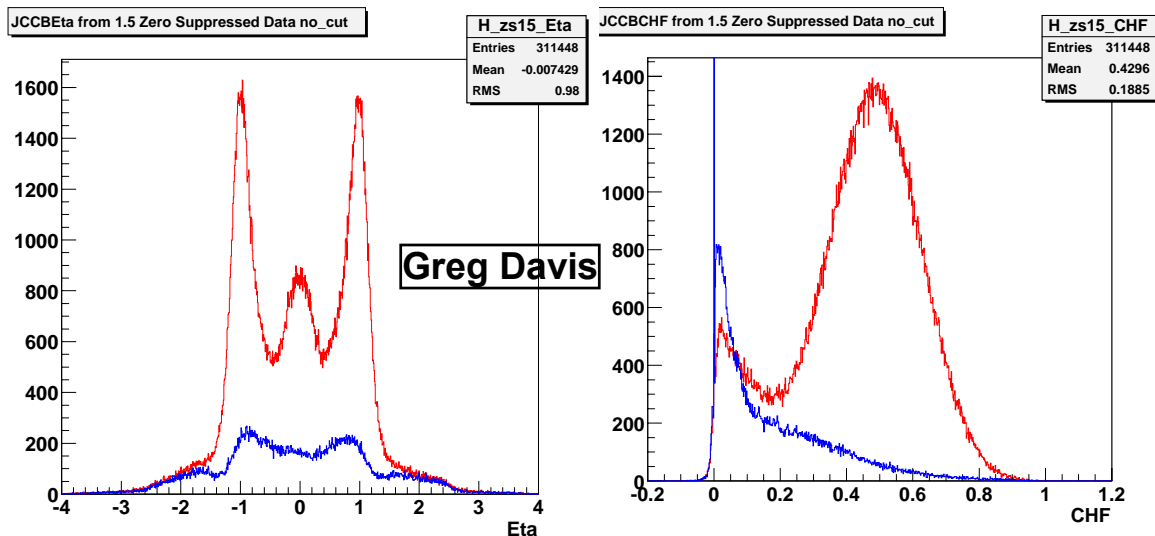
- with only 1.5 online zesu
- and with 2.5 offline zesu

- Data with

1.5 online + 2.5 offline
are similar (but not identical)
to data in special run with
2.5 online

- Before, interpretations were
confused by other calorimeter
issues

(non-linearity corrections, event
misalignment, trigger changes...
all occurred during June)



Offline zero suppression

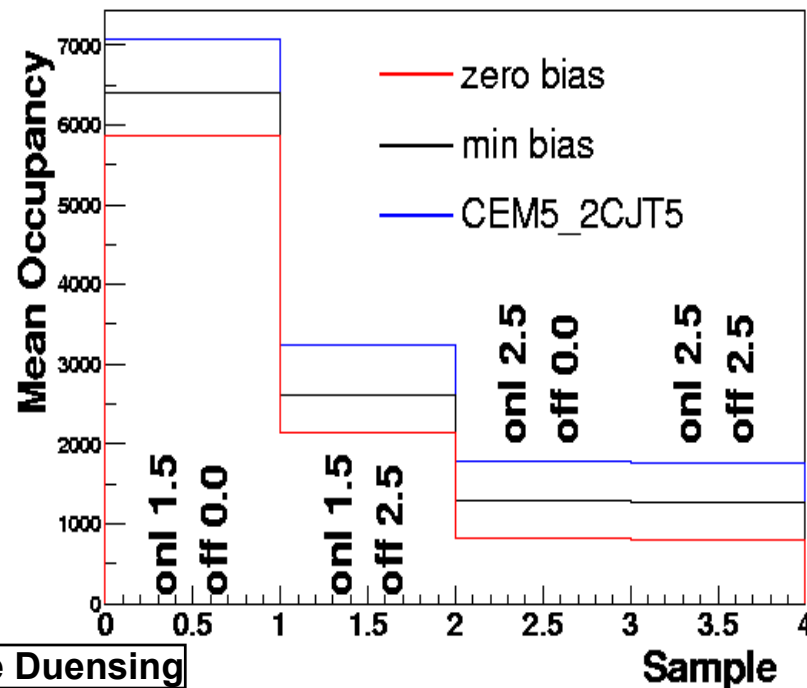
- `calunpdata` package has been modified to apply offline zero suppression similar to the hardware -- “ 2.5σ ” default
 - ➔ comparison is “ $<$ ” instead of “ \leq ”, the offline zesu is softer, effectively $\sim 2.1\sigma$
- Suppression done in ADC counts before any corrections (non-linearity, gains, etc)
- Pedestal threshold file taken from online for a calibration run
- Implemented in p11.11 (Aug 10)
- BUT: L3 is protected only by the online cut at 1.5σ -- and suffers from similar problems...

Occupancies

Leslie Groer

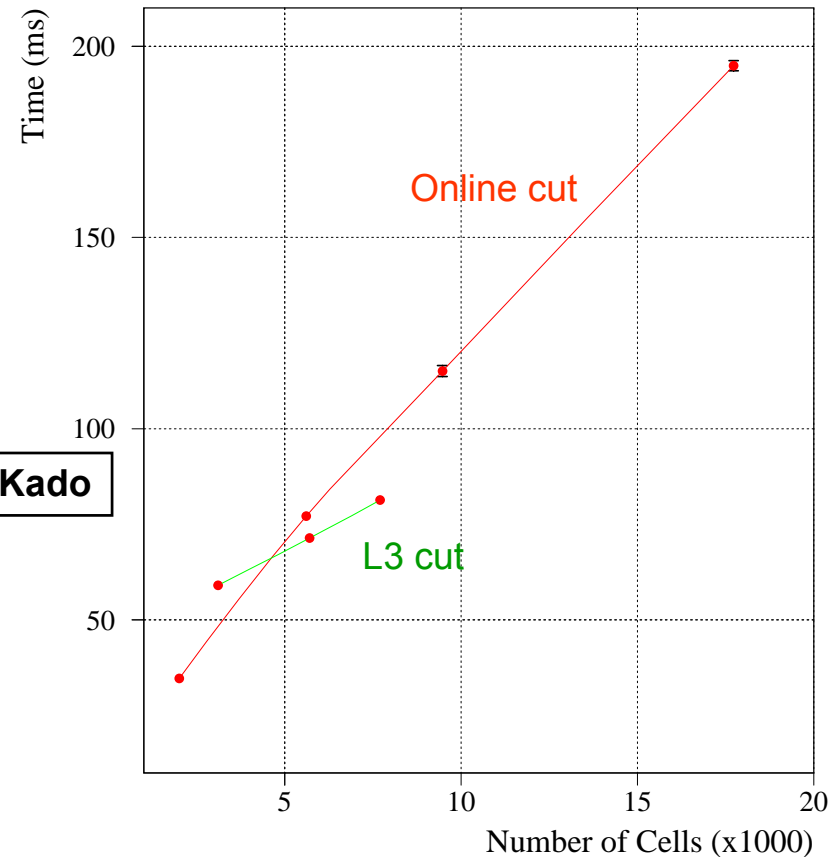
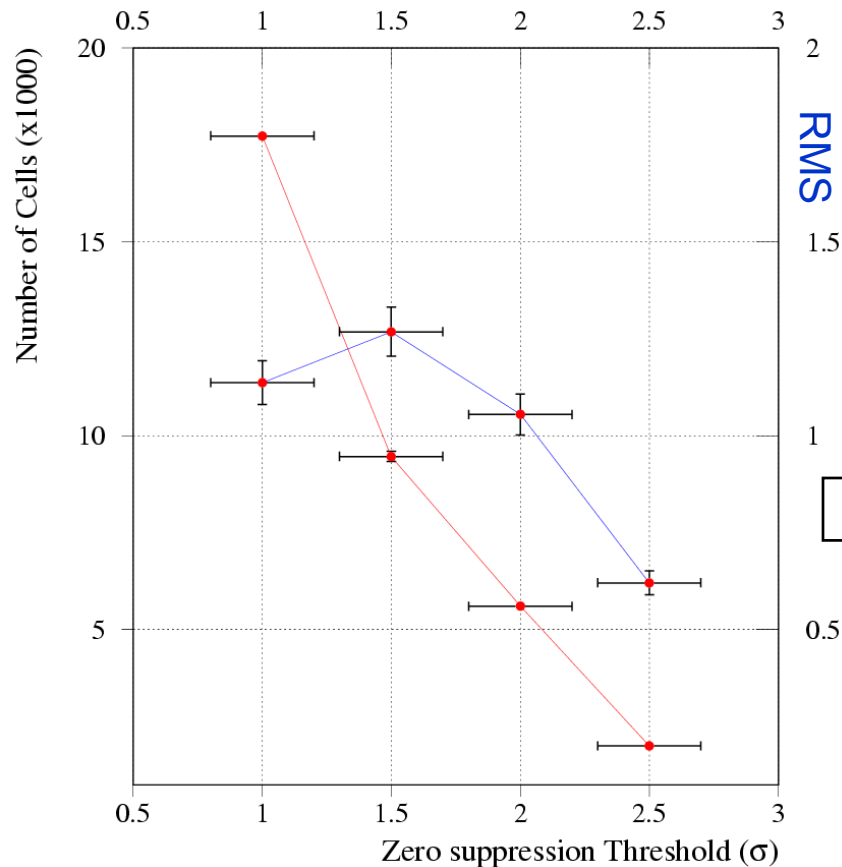
• Rough guess, based on effective zesu:

- 1.5 online/0.0 offline 5800
- 1.5 online/"2.5" offline 2100
- 2.5 online 750



Silke Duensing

Suppression and L3



- The thresholds have NO effect on L1 and L2 triggering or readout
- Unpacking time scales ~linearly in L3
- Will have to apply a threshold before filtering algorithms
- L3 calorimeter issues under review by Marumi Kado & Markus Klute

So, what's the noise?

- Noise in detector (per cell, in MeV)

calibration by Robert Zitoun, in p11.13.00

15-50 EM, 60-90 FH, 300 CH, 450 OH

(Run1: 10-15, 40-70, 100, 80)

With 1.5σ zero suppression, it is not hard to create 5 GeV of noise energy within the jet cone in CH/OH, or a jet seed of 500 MeV

- Noise in MC simulation

has been underestimated by factors:

2-2.3 EM, 2-2.8 FH, 2-3.2 CH/OH/MG, 8 ICD in p11.xx (except xx=13) and in p12

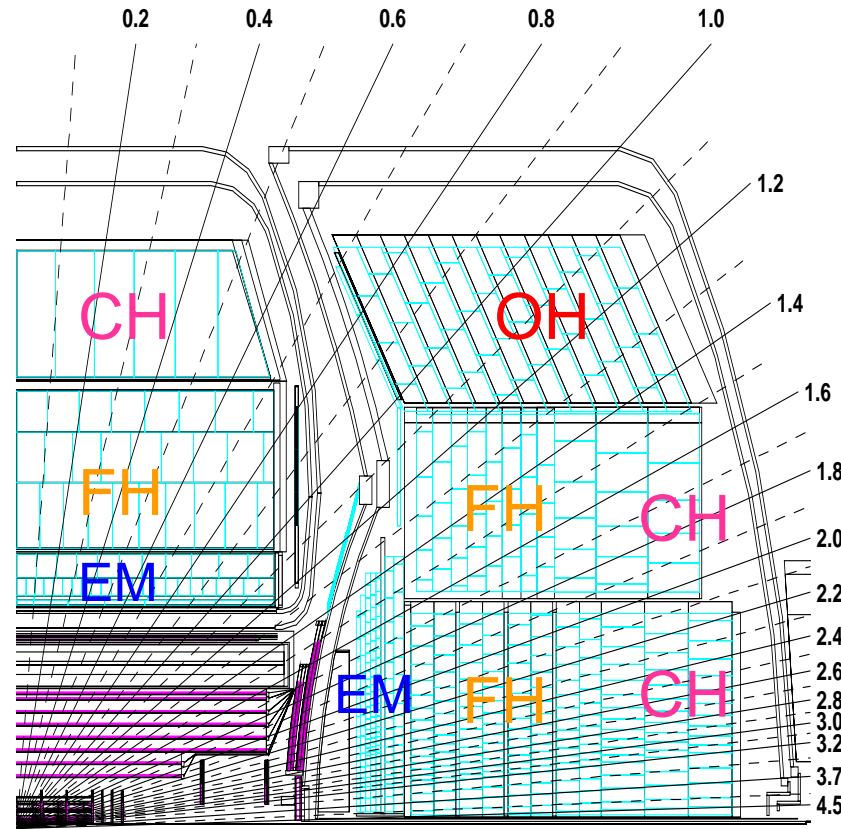
and by factors

6-10 EM, 3 FH, 25 CH, 15 OH

up to p10.xx (with no noise in ICD and MG)

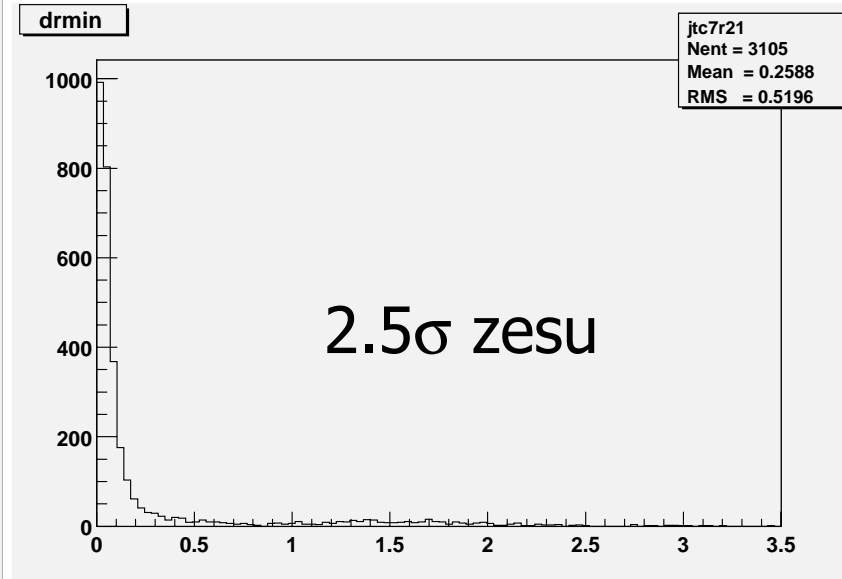
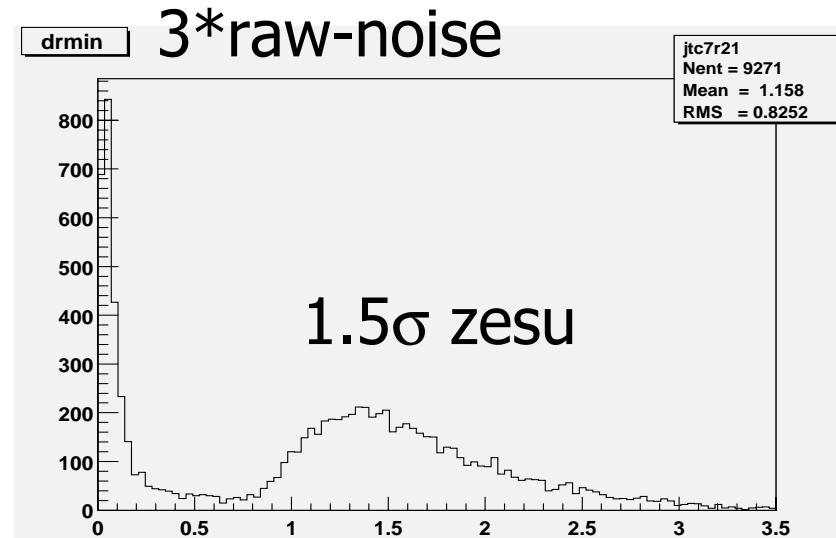
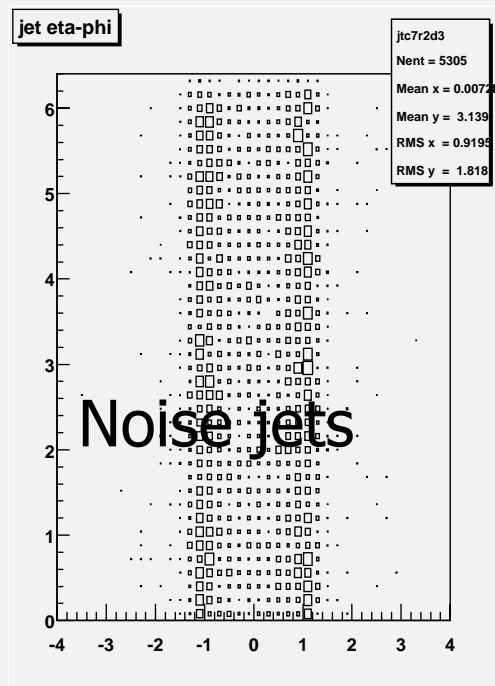
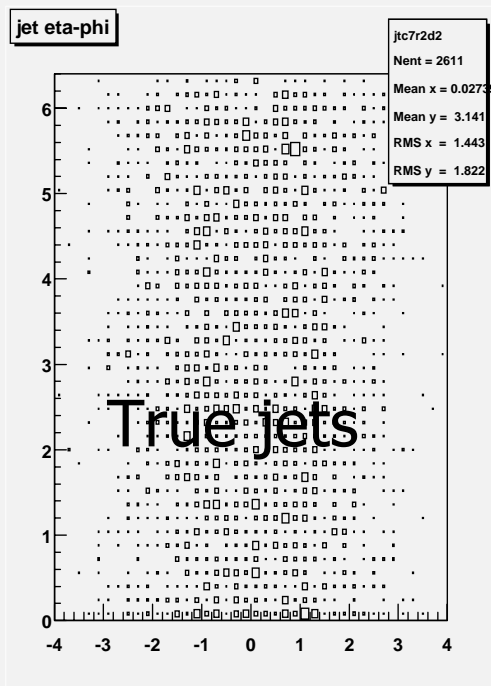
P10.15 was our major MC production so far!

- A “lucky bug” in the d0sim code inflated the effective noise by factor 1.4 – but it was fixed in p11.12...



Jets and noise

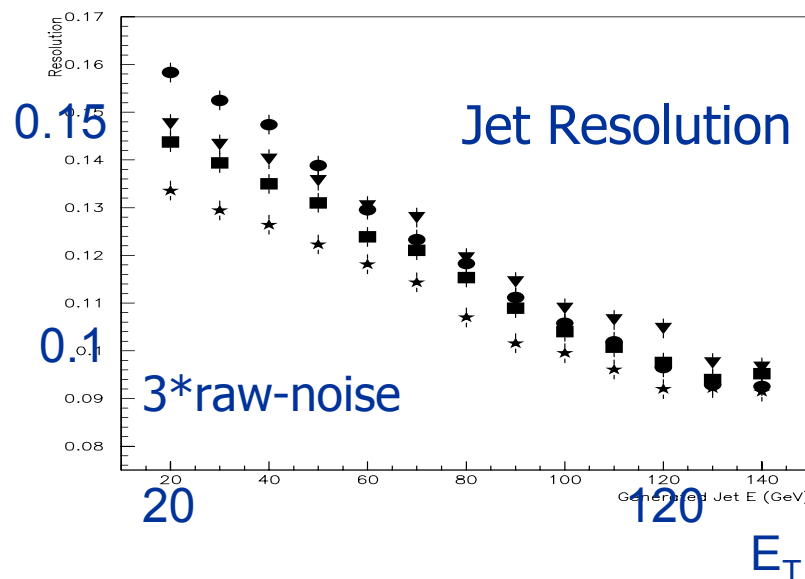
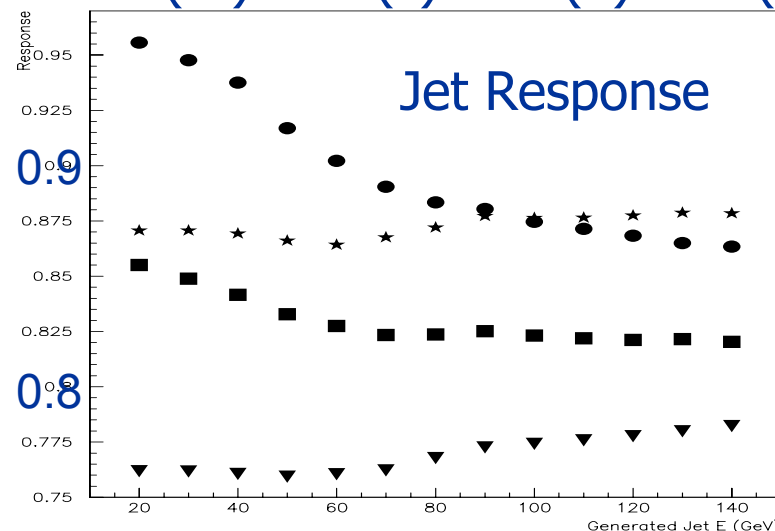
- Vishnu Zutshi studied jet behavior in MC with roughly correct noise
 - drmin is matching distance between reco and generated jets
 - Many fake jets formed with 1.5 zesu
 - Much cleaner for 2.5 zesu
 - Most fake jets in ICR



Jets and noise - II

- This study suggests that optimal zero-suppression for jet response and resolution may be around 2σ
- Then need further protection against fake jets:
 - ➔ Higher z_{esu} only in CH/OH?
 - ➔ Higher requirements for seed towers? (currently 0.5 GeV)
 - ➔ Restrict seeds in CH/OH?
 - ➔ Compensate by including negative calls/towers?
 - ❖ Worse response, resolution
- Many combinations to sort out
 - ➔ John Krane is developing a “Toy MC” to allow quick insights

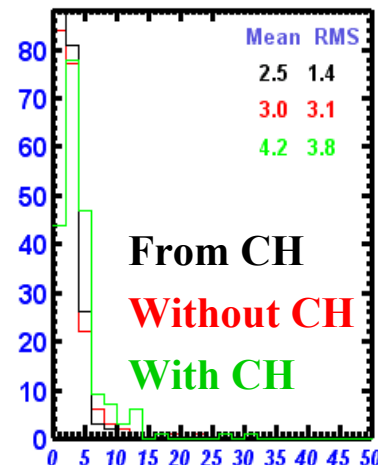
No-noise(★) $1.5\sigma(\bullet)$ $2.0\sigma(\blacksquare)$ $2.5\sigma(\blacktriangledown)$



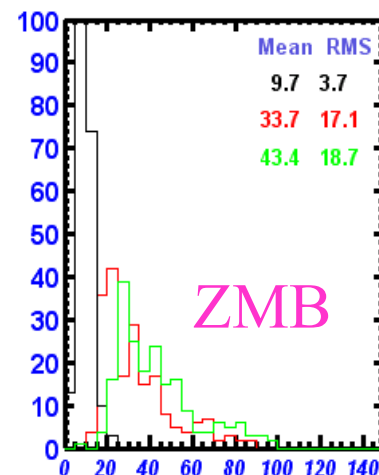
MET, SET and CH

- First look at the influence of CH layers on MET and SET
 - ➔ CH provides >20% of scalar E_T in both Zero+MinBias events and QCD events
 - ➔ The difference between CH energy in both event samples is not large
 - ❖ 9.7 GeV in ZMB, 14.3 in QCD
 - ➔ CH layers contribute significantly to MET
 - ➔ The Mean and RMS values are much higher at 1.5σ
 - ➔ Is CH adding more noise than physics signal?
 - ➔ How to handle negative cells?
- Need more studies...

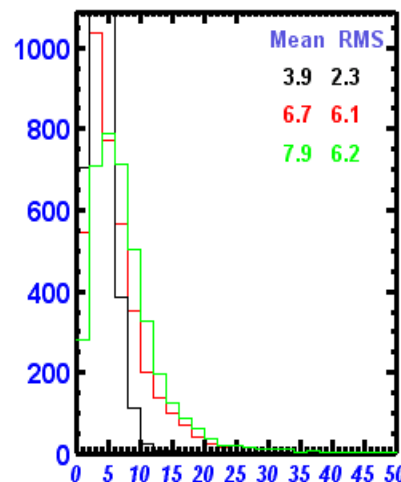
Met



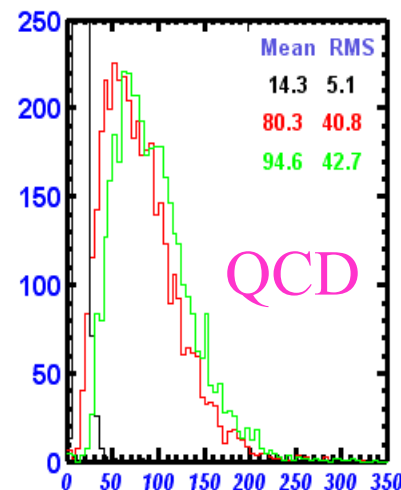
Set



Met



Set



Stephanie Beauceron

2.5 σ run

Status of calorimeter MC

Code status:

- Noise simulation file in pileup is low by factor of ~ 2 -3 (corrected in p11.13)
 - ➔ No resistor swap factor incorporated (1.39 \downarrow)
 - ➔ No linearity correction applied (1.5-1.7 \downarrow)
 - ➔ Double-gaussian “lucky bug” for noise simulation corrected in p11.12
 - ❖ actually worse noise simulation!
- Noise simulation in pileup in GeV
 - ➔ Intend to switch to ADC
- Calorimeter z_0 offset by 2.9 cm
 - ➔ Introduced in p12.03
- ICD ADCtoGEV low by at least 35% determined from MIP calibration
- Bug in offline “2.5” sigma cut – same as for p11.11 data

Current CTF production at UTA farm:

- D0gstar files generated with p11.10
- Currently using p11.12.01 for d0sim/reco, with two rcp changes
 - ➔ cal_noise.rcp in pileup from Robert Z
 - ➔ d0sim suppression lowered
- Also mc_runjob updates
- No useful objects present in rootuples – under investigation
- Processed 10k each of
 - ➔ $Z \rightarrow ee$
 - ➔ $Z \rightarrow \tau\tau$
 - ➔ QCD $p_T > 20$
- Pending requests
 - ➔ gamma+jet $p_T > 20$
 - ➔ $W \rightarrow e\nu$
 - ➔ QCD, higher p_T thresholds

Interim Proposal for Data

Zero suppression:

- Keep 1.5 sigma threshold online
- For offline suppression:
 - ➔ Correct the bug in 2.5 sigma suppression; stay at 2.5 threshold
 - ➔ Use Robert Zitoun's pedestal width measurement
- Apply the same suppression at L3
 - ➔ this will affect L3 trigger objects dramatically – improve rejection
 - ➔ will introduce a second data set

Beyond zesu:

- Correct ICD ADCtoGEV based on MIP measurements (x1.35)
- Correct CC MG layer weight for feedback capacitor gain factor (x1.9)
- Reprocess all p11.xx data after June 26th (ignore the mixed event data for now — July through Aug 15)
 - ➔ “redo” L3, but not tracking?

A wish list:

- Modify jet algorithms to protect against effects of CH noise
- Turn on L3 NADA for MET and jet objects (and electrons?)

Processed so far (Mevents)

<u>Version</u>	<u>Raw</u>	<u>Processed</u>
♦ p10.15	75	55.0
♦ p11.09	11	9.9
♦ p11.11	85	11.6
♦ p11.12.01	19	6.1

<u>Month</u>	<u>Raw</u>	<u>Processed</u>
♦ Jun	5.2	2.2
♦ Jul	22.0	9.7
♦ Aug	23.0	10.2
♦ Sep	31.7	11.0
♦ Oct	2.4	0

Interim Proposal for MC

- Two options for noise simulation:
 - ➔ Use the new phi-averaged noise file (in GeV) in pileup (from p11.13)
 - ❖ Exists already, we should see MC files soon
 - ❖ Zero suppression in reco, only a precut in d0sim
 - ➔ If new pileup code is ready, apply Robert's cell-by-cell noise measurement in linearized ADC
 - ❖ **The preferred method**
 - ❖ Use Robert's raw ADC noise file for suppression in d0sim
 - ❖ Still needs to be completed, released and verified
- Correct offline “2.5” bug and ADCtoGEV in ICR (same as for data)
- Apply calorimeter z_0 offset in d0gstar

Unfortunately, no MC studies yet to show that the new noise simulation matches the current data more closely ...

Studies needed in the next few months

- Get MC samples to study effects in response, resolution and identification efficiencies as function of threshold schemes
 - ➔ jet, MET, electron, photon...
 - ➔ Comparisons between MC and data
 - Explore different suppression schemes:
 - ➔ Threshold dependent on i_{layer} ?, i_{eta} ?
 - Other modifications to algorithms?
 - ➔ Noise in CH and OH is relatively larger by a factor ~ 2 -3 compared to the other layers than was the case in Run I
 - ➔ Eta's in the far forward (>3) region have ~ 3 -4x the occupancy
- Noise samples (single ν)
 - $Z \rightarrow ee, \tau\tau$
 - $W \rightarrow e\nu$
 - QCD $p_T > 10, 20, 40, 80$ GeV
 - Photon + jet
 - B-jets, Top, Higgs, ...



Outlook

Expected work for the final report (01/15/03)

- Raise online threshold slightly
 - ➔ Readout times become more of an issue at higher DAQ rates (~ 1 kHz) to reduce FEB
 - ➔ Data size reduction translates directly to saving in storage media costs
- The fine-tuning could have layer and eta dependencies
 - ➔ Readout time determined by the crate with highest occupancy
 - ❖ Suppressing forward regions can help a lot with little effect on ET
 - ➔ 1.5 \rightarrow 1.7-1.8?
- Similarly, drop the offline thresholds somewhat at least in some layers and maybe some etas
 - ➔ 2.5 \rightarrow 2.0?
- Utilize the calibrated pedestal widths for the actual run both at L3 and offline from the database
 - ➔ Requires significant infrastructure work to calunpdata
- Use unsuppressed zero-bias data for pileup overlays

Work beyond the CTF

- Need to strengthen the effort in the calorimeter software group and related ID groups
 - ➔ Cleanup and consolidate simulation and reconstruction code
 - ❖ conversions in cal_tables and cal_weights
 - ❖ integrate preshower information
- Many things should be studied in longer term
 - ➔ Evaluate robustness of algorithms at high luminosity
 - ➔ Readjust layer weights, or apply layer corrections for energy lost due to zero suppression on the object level
 - ➔ Develop algorithmic protections
 - ➔ Reevaluate the use of negative energy cells and towers
 - ➔ Revisit d0gstar choices for shower development
 - ➔ We are accumulating a list of needs...
- Need new active contributors!



Status of production versions

- Major versions of reco used
 - ➔ p10.15 Feb 12
 - ❖ Cal weights corrected for resistor swap
 - ❖ Dynamic NADA in kill mode
 - ➔ p11.09 Jun 1
 - ❖ NLC first applied
 - ❖ ICD ADCtoGeV corrections
 - ❖ ICD addressing corrections
 - ➔ p11.11 Aug 10
 - ❖ “2.5” offline suppression
 - ❖ NLC correctly applied
 - ❖ ICD addressing corrections
 - ➔ p11.12 Sep 14
 - ❖ Single gaussian for noise simulation
- June 18-Aug 15 FPGA code v26+27 mixes events in multi-buffer mode
- Offline suppression in p11.11 has a bug
 - ❖ “<” used instead of “<=” in suppressing cells i.e. cut is about 2.0 to 2.4, depending on layer
- L3 NADA tested and runs but not used
 - ❖ CPU time tends to scale linearly with occupancy (i.e. threshold)
 - ❖ No “offline” suppression at L3 yet
- ICD ADCtoGEV still low by at least 35%, determined from MIP calibration
- June 26 – changed from 2.5 to 1.5 sigma in the online data taking
- CC massless gap $\eta_{\text{eta}}=8$ ADCtoGEV off by a factor of 1.9